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ERRATA FOR HENSON'S MODERN ASTRONOMY.

Page 13, line 1 read about 18,847° it's brilliancy would diminish somewhat towards the close of the period but not entirely disappear.

Page 14—line 28, read attractions *become* superior.

Page 18—line 15, read *convection* in place of connection.

Page 25—line 18, read perihelion for perehelion.

Page 26—bottom line, for 78611554 read $\frac{1}{78611554}$

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THE GREAT FACTS

OF

MODERN ASTRONOMY,

WITH AN EXPOSITION OF WHAT THEY TEACH

COMPRISING THE

Formation of the Sun and Stars,

THE CAUSE OF ROTARY MOTION,

THE FORMATION OF

THE PLANETS AND THEIR SATELLITES,

SOLUTION OF

THE LAW OF DISTANCES,

THEORY OF LIGHT, AND

THE SUN SPOTS.

1871

BY WM. S. HENSON, Mechanical and Consulting Engineer

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PREFACE.

About seven years ago, during some of the leisure evenings of a temporary sojourn in South America, my attention became attracted to the relative positions of the sun and planets of our solar system. Their positions impressed me as indicating the action of centrifugal force, or, in other words, the position of drops of water thrown from a rapidly revolving grindstone, and, after considerable examination and thought, I became convinced that it was so; for when I considered the motions of the planets, that they were all revolving on their axis in the same direction as the sun, viz: from west to east, and all moved round the sun in their orbits from west to east, and the satellites of our earth, Jupiter and Saturn, also moved round their primaries from west to east, these facts struck me as a remarkable coincidence, which the Nebular Hypothesis of La Place appeared to be totally inadequate to account for. I finally concluded they must all have been thrown from the sun, but how and by what means did they get into their orbits, were the questions which presented themselves, and it was not until the autumn of 1869 that I succeeded in solving these problems to satisfy the conditions of the case.

The solution of the law of distances, known as the Bode law, followed as a sequence, of the aggregation of immense quantities of debris flying round the sun, nearly in the same plane, in very eccentric orbits, and interlacing with each other. I submitted everything, as far as I was able, to the test of actual experiment, which has enabled me to speak more confidently than I otherwise could have done from theory alone. The main facts of astronomy I obtained, to some extent, from Herschel's outlines, but I am chiefly indebted to Humboldt's cosmos. My information on spectrum analysis I obtained from Roscoe's able work on that subject. I found myself anticipated by Mayer on the mode of producing heat by collision. Mayer also first suggested meteors, or falling stars, as fuel for the sun, as I learned, first about the year 1869, from Enniss' origin of the stars. To Mayer belongs the honor of discovering the mechanical equivalent of heat, as I also first learned from Van Nostrand's Magazine, in 1869. The theory of aggregation and its laws, as described, and the cause of rotary motion I am responsible for, as also for the conclusions drawn from Newton's laws of motion respecting revolving bodies, whereby I have shown, step by step, that the motions of the planets reveal their own history. The

laws of aggregation round a centre are also due to myself, as well as the solution of the law of distances, which necessarily formed a part of the law of aggregation round a centre, and which accounts for the astronomers not being able to comprehend it.

My views on light I arrived at not only from the necessity of the case, but because without it so many things are left unexplained. I am, therefore, compelled to believe it; in the absence of sufficient evidence to the contrary, I cannot but believe that light is really matter. To my mind it appears to be the one or more elements from which everything is created, as everything is converted into light by the intense perfect combustion in the solar fires. Newton assumed that light was matter, and spectrum analysis indicates most clearly that light consists of every known substance. Being matter, it became, of course, proper to treat it accordingly. I believe I am the first to assign its density; its extreme levity explains why it had baffled all attempts hitherto made to weigh it; its action upon the sun's motion gives also reasonable data for an approximate estimate of the age of our system and the world.

It must not be expected, in view of the circumstances under which this work has been produced, that the calculations should be anything more than tolerable approximations. I make no pretensions to be an astronomer, or to enter into the extreme exactness of that exalted science, but the business of my life has made me familiar with mechanical motions; and believing that I have traced the motions of the planets to their source, I have undertaken, in my own way, to make it known. If it is truth, as I believe it to be, it will stand; if it can be shown that it is not true, let it fall.

WILLIAM S. HENSON.

GREAT FACTS OF MODERN ASTRONOMY.

I. Nicolaus Copernicus, who flourished in the beginning of the 16th century, was the founder of the system bearing his name, by which the complicated ptolemaic system was overthrown. He placed the sun (*Lucernam Mundi*) in the centre of the universe, with the planets moving in circles round him. Kepler discovered the three celebrated laws which bear his name, and that the planets moved in elliptic (not circular) orbits round the sun. Galileo and Jansen invented the telescope. Sir Isaac Newton discovered the laws of gravitation, and demonstrated that the planets were held in their orbits thereby. Sir William Herschel, by means of his great telescope and observations on the binary star systems, where two stars connected by mutual attraction, revolve round each other in very eccentric orbits, demonstrated that the action of gravitation prevailed throughout the visible universe. With our present knowledge, every star may be considered as evidence of the same fact, for without it there could be no stars. The telescope gave an immense impetus to astronomical discoveries, for a detailed account of which, during the 17th, 18th and 19th centuries, I will refer the American reader to the 4th volume of Harper's reprint of Cosmos, page 100. The discoveries in our solar system comprise the satellites of Jupiter, the rings and satellites of Saturn, the discovery of Uranus and Neptune and their satellites, and 113 asteroids, in a zone or belt, between Mars and Jupiter. Five planets only were known to the ancients, viz: Mercury, Venus, Mars, Jupiter and Saturn, the Earth being considered the centre of the universe, round which the sun, moon and stars all revolved. It has long been definitely settled that the sun is the centre of our solar system, and revolves on his axis from west to east; that the planets also revolve in their orbits from west to east, and also on their own axis, as far as known, from west to east. The satellites of the earth, Jupiter and Saturn, also revolve round their primaries from west to east; the satellites of Uranus being exceptions to this rule, and move in orbits somewhat retrograde, and nearly perpendicular to the plane of the ecliptic; Neptune's satellites also deviate considerably from the plane of the ecliptic, while all the principal planets and their satellites, excepting the above, and some few of the asteroids, deviate but slightly from the plane of the ecliptic; and the plane of the sun's equator inclines only about seven degrees therefrom. With this brief outline of the main facts relating to our system, I will now make a few observations on some of the modern discoveries in the starry heaven

II. Humboldt in his Cosmos, assigns to Bradley the credit of the first hint of the translation of the whole solar system through space (in a work published in 1748); but he awards to Sir William Herschel the credit of being the first to verify the conjecture by actual observation (from 1783 to 1806). Sir William Herschel discovered that our system was moving towards a point in the constellation Hercules, which has been since confirmed by others; he also discovered that all the stars in the Sidereal Heavens were in motion, but he found nothing to indicate that they moved round a central sun. Here we arrive at the important fact that everything in the visible universe is in motion, and when we behold their varied distances, and take into consideration the universal influence of gravitation and its laws, we are compelled to conclude that the normal condition of the Sidereal Heavens is one of unbalanced equilibrium, containing the elements of constant but slow change; but I will speak of this again presently.

In the year 1837 Struve published his third table of multiple stars, containing 2,787 double stars, and Sir John Herschel, during his residence at the Cape of Good Hope, discovered 2,100 more; with others, Humboldt makes the total number 6,000. Among the multiple stars, several self-luminous bodies are connected by mutual attraction, and revolve around a common

III. centre of gravity, in very eccentric orbits. The so-called Nebulous spots or masses are very numerous; the number whose positions have been determined exceed 3,600; some of the more irregularly diffused measure eight lunar diameters. (Cosmos, vol. 4: page 14). These remarkable bodies have led to much discussion and many conjectures as to their origin and constitution. According to Sir William Herschel, they cover at least 1-270th part of the visible universe; he supposed some of them to be clusters of stars, so distant as to require a million of years for their light to reach the earth. According to Professor Roscoe, in his work on spectrum analysis, (page 250) there is good reason to doubt this immense distance. The spectroscope indicates the existence in some of the Nebulous spots of gaseous matter, while the increased power of the telescope has shown others to consist of clusters of stars. The Nebulæ vary greatly in form, according to Humboldt; they are either regular or irregular, and as difficult to classify as clouds. Some are globular; more or less elliptical, annular, or planetary. The elliptical (spheroidal) form has been regarded as the normal type of Nebulæ. The planetary Nebulæ are more rare, according to Sir John Herschel, not more than twenty-five in number; they are round or somewhat oval, either sharply defined or vaporous at the margins, and bear a strong resemblance to planetary discs.

Sir William Herschel, after prolonged consideration from 1799 to 1802, adopted the theory of star formation through the gradual condensation of cosmical vapor as Halley, Lacaille, Tycho, Brahe and Kepler had done be-

fore. Humboldt intimates here that this theory and the Nebular theory of La Place are not necessarily identical. With this preliminary outline-

IV. I will for the present cease further remarks on the subject of astronomical discovery, and give you some views of my own upon the subject of condensation, aggregation, and some of the effects resulting therefrom, which I have arrived at during the past seven years.

There appears to be considerable misapprehension as to the *modus operandi* of the condensation of vapors. In order that you may intelligently comprehend what I am about to advance, I will first explain how steam and the vapors of clouds are condensed into rain. Steam blown from a boiler into the cooler atmosphere, immediately condenses into the minute particles forming a mist or fog; these particles seek each other by attraction and unite, first two together, then these double parts unite with other double parts, and so on repeating the process until their united masses commence to fall as rain, by their increased gravity; while it existed in extremely minute particles, it floated in the air like dust, but these particles will not commence to unite without mutual attraction. In the case of steam, the difference of temperature and the act of condensation creates electrical disturbance, and that produces attraction; so warms clouds containing much vapor, are brought by currents of air in contact with other clouds of lower temperature, above or below, electrical disturbance takes place, the particles of vapor attract each other, unite, and commence to descend; others in close proximity do the same; they attract each other during the fall, and unite; the larger drops fall with greater velocity, and overtake the smaller ones and unite with them, and if the electrical disturbance is strong, the attraction extends to greater distances and produces the large drops, so far apart, well known to emanate from thunder clouds. It is well known, also, that solid matter, when subjected to great heat by the process of sublimation, condenses by cold, in some cases into a very fine power, as sulphur, zinc, &c.; camphor, mercury or quicksilver can also be sublimated, and probably most substances in nature, provided sufficient heat is applied. After long consideration, I arrived at the conclusion that there must have been a time when our earth and sun, and all the stars which stud the Heavens, were once in the condition of extremely fine dust and vapor, scattered with a uniform irregularity through the vast space now occupied by them. How I arrived at that conclusion I will explain as I proceed:

V. If we observe the stars scattered over the vault of Heaven, we do not discover any regularity in their arrangement, but rather what may be more properly called a uniform irregularity, like the positions of rain drops on a pavement at the commencement of a shower. The distance of the nearest fixed star—a centauri—has been estimated by astronomers by distances of Neptune from the sun, that is by 7,523 times 2,488 millions of miles, (Cosmos, vol. 4,

page 54), and it being interesting to know the ratio of the cubic contents of the sun and planets to the cubic contents of a sphere in space, extending from the sun's centre to half way to a centauri, in order to ascertain how much the matter composing them would require to be attenuated, to fill their share of space, I found by calculation that it would be as 14,281,927,982,-779,922,916,215 to 1, or as a range of 23 figures to 1, and that each cubic foot of matter would have to fill 78,576,605,462 spherical miles, or a sphere equal to 4,283 miles diameter. A single grain would occupy 114,407 spherical miles equal to sphere 48½ miles diameter, and the one-millionth part of a grain would be contained in a sphere about half a mile diameter. It will be evident that matter divided into particles of one-millionths of a grain would be in the condition of a very fine powder, and as the weight or gravity of the one-millionth part of a grain is only such when attracted by a sphere, the size and density of our earth; it will be evident how almost infinitely small must be the attraction of two such atoms for each other, situated about half a mile apart, and that extreme diminutive attraction, still further reduced or almost balanced by the attraction of other atoms, situated at various distances round it. From this we may form a very faint idea of the immense period of time it would require for two such atoms, situated about half a mile apart, to attract each other and unite; yet in the process of aggregation this must have been accomplished and repeated a great number of times, yet not so many as it would at first sight appear. When aggregating by a geometrical progression, 2 being the constant mutiplier or ratio, I find that with every increase of 8 the diameters of the aggregated masses will be double; the distances will also be double, and the power of attraction of every mass or sphere for every other mass or sphere, at that double distance, will be also double; but according to Newton's Second Law of Motion, double the power gives double the velocity, therefore, although the distances are double, the mean times will remain constant; it follows, therefore, that the mean time required for those atoms of one-millionth of a grain, situated at mean distances of about hatf a mile apart to unite, is equal to the time consumed since our sun last doubled itself by aggregation, until it again doubles itself in the remote future; and the stratified condition of our earth appears to indicate that this period of time must have extended through many millions of years. I find that the process of aggregation from atoms of the one-millionth of a grain, to the stupendous mass of our sun and his planets, would require only 213 duplications, yet when we consider that the mean periods or times of these duplications, are all equal, and how long the present condition of our system has existed, we get a faint glimpse into the remote depths of the past Eternity, and realize how extremely slow is the process of aggregation.

Sir William Herschel and others have verified the great fact of motion being everywhere, and knowing the tremendous, far-reaching influence of gravitation, the conclusion seems irresistible that this process is yet going on, and that the creation of our earth and its inhabitants in the economy of the great ruling intellect, is but one of many incidents inevitable during this process, as I will presently endeavor to demonstrate. Notwithstanding what I have hitherto

VI. advanced, and although the process of aggregation, as far as described, is perfectly consistent with facts, yet without further demonstration, I could scarcely expect you to realize as I do myself, the truth of what I have endeavored to convey to you, but I will proceed. With equal densities, the attraction of spheres upon their surfaces varies directly as their diameters, and the velocity which a falling body will attain in one second near their surfaces, varies directly with the attractive force. The attraction of the sun is so tremendous as to bring back the comet of 1680, from 28 of Neptune's distances, after an estimated absence of 8,000 years; the motion of the comet became so much accelerated, that during its perihelion passage its velocity was estimated at 344 miles per second; according to the best authorities it passed within one-sixth of the sun's diameter from the surface of the sun, and it is presumed that if it had gone quite to the sun and during that fall been subjected to the immense attraction from near proximity, it would have attained at least 887,775 feet more velocity, and this latter, added to the first, would make a total of 2,704,074 feet per second; and as during the process of aggregation the falling distances would increase directly as the diameters; and the force of attraction would increase as the diameters, it follows that the velocities of two colliding bodies will be as the diameters during every stage, providing the densities are equal. The commencement of aggregation will therefore be chiefly remarkable for its silent darkness, intense cold, and apparent absence of motion. It will require about 117 duplications, each with its immense periods of time, to bring the aggregated masses to the volume of a cubic foot, and the motion produced by attraction, even immediately preceding conjunction, at this time, will not exceed the thirty-millionth part of a foot per second; the 156th duplication will bring the aggregated masses to the dimensions of a spherical mile whose surface attraction would be thirty seven millionths of a terrestrial pound. They would be in the condition of spheres of the softest impalpable dust, and the least violence would dissipate them into clouds, but the united terminal velocities immediately preceding conjunction would not exceed 5 feet per second, effecting the union in the most gentle manner without disturbing the prevailing silence. The 177th duplication would bring them to the period when heat would commence to be developed by the velocity and momentum of the united masses; the united terminal velocities would be about 757 feet per second at this time, yet the force of gravitation would be only about the five one thousandth of a terrestial pound a marked change

would now commence, the minute atoms of frozen watery vapor would begin to dissolve into liquid, and form with the dust a more or less pasty consistence, this would again become deeply frozen in the long period of cold and darkness following; and being commingled with air throughout would form a light porous homogenous mass of about 188 miles diameter. At the 192nd duplication we arrive at a period of great heat, temendous storms of rain, formation of rivers, a general commingling of matter, a stormy, steaming, chaotic period, during which the internal heat would create upheavals, and form mountains, lakes and oceans, and deposit strata, and as the surface cooled living organisms and vegetation of various kinds might exist, the mean temperature at the commencement would be about 218° Fahrenheit, but the surface would gradually cool by radiation to a more temperate heat, and would probably during the last half of this period become frozen solid, as up to this time it would be the most profound darkness. At each of these last duplications considerable rotary motion would probably be produced and great dark nebulæ formed. Up to the 195th duplication would be characterized by increased heat and like a steaming, seething cauldron be too hot at their commencement for either animal or vegetable life; they would also be remarkable for the violence of the rain storms, such as we can scarcely imagine; produced by the immense condensation of the atmosphere of steam, these stormy floods, and the violent upheavals, would produce an immense amount of grinding and depositing, the denser ingredients would become separated from the lighter ones and form deposits by themselves. The last duplication would be remarkable as first producing light, a bright red, visible by day, with a mean temperature of about 1168° Fahrenheit, at this conjunction a large number of elementary bodies would be melted, the water and many other substances would be converted into vapor, this period would be the commencement of the ordeal and assortment by fire; the great heat would produce violent upheavals, and commingling of enormous masses of matter; the later half of the period would probably be cool enough to allow the steam to condense into water, and again produce another period of storm and rain and violent floods and great deposits; each conjunction accompanied by rotary motion and the formation of nebulous masses with temporary luminosity, but all becoming invisible after a short period from the obscuration of dense clouds caused by condensation near the outer limit of the atmosphere. The three succeeding conjunctions up to 198 and their periods would be remarkable for the great increase of temperature the last one having a mean temperature at commencement of 4,674° Fahrenheit about one fourth more than molten cast Iron, the surface would propably become dark during the first part of the periods and the latter part be subjected to a repetition of the tremendous floods and storms. The next three conjunctions up to the 201st and their periods would be characterized by greatly increasing temperature of a

brilliant red color; temperature during the commencement of the last about brilliancy would diminish somewhat towards the close of the period but not 18,847°, its entirely disappear. The next three conjunctions up to the 204th would be characterized by increasing splendor and a mean temperature at commencement of the last conjunction of 105,546°, the diameter would be about 96,350 miles, it would now become a permanent sun with considerable rotary motion and at the last conjunction throw out masses of debris and vapors and form nebulæ, and a planetary system, about the size of Jupiter and his satellites, the planets would probably be inhabited. Nine more conjunctions up to the 213th would bring us to the dimensions of our own magnificent sun and his subordinate planets, each of these conjunctions would probably be characterized by nothing remarkable except increasing splendor, all would probably be accompanied by rotary motion, throw off nebulæ, and form planetary systems; each increasing in size with the increase of the sun's diameter, and probably each system of planets more or less inhabited by beings endowed with instinct, and intelligence, and in every way adapted to the habitats assigned them.

VII. I will now explain how rotary motion is produced by the attraction and collision of two spheres, I will also explain the formation of Binary systems and nebulæ, the approaches of two spheres towards each other would almost invariably be made on more or less curved lines, produced by the disturbing influence of other spheres, and when these curves were opposite to each other, and moderate in degree, each sphere would strike the other on opposite sides of the common centre of gravity, this would impart rapid rotary motion to the united mass, as the whole mass of each would impart its weight and momentum on the one side only, of the other, and the former curvilinear motion would become converted into rotary motion. If the approaching lines were considerably curved either from previous motions or disturbing influences during the approaches, the two spheres instead of colliding would pass round each other, and a common centre of gravity situated between them; and again go off into space in very eccentric, elongated orbits; but if the approaching lines were so curved as not quite to allow the spheres to pass each other; but to strike their near circumferences on tangential lines, the outer sides of each sphere would immediately have an increased velocity, much greater than the velocity of the spheres, but never quite double on account of the grinding and slipping action at the sides in contact; each sphere would become converted into a lever of the second order, the sides in contact being the fulcrum, and the whole weight tending to double the velocity of the outer sides creating rapid rotary motion and throwing off from these outer sides, enormous quantities of debris to immense distances into space approaching the half way to the nearest stars; (indeed were it not that a considerable amount of the momentum was converted into heat, it would

throw quantities of debris more than half way) and this debris would fly off in nearly one plane, like sparks from a revolving rocket; and this would be first a burning star suddenly appearing of immense size in consequence of the enormous generation of heat, and the quantities of heated debris flying off into space, such as seen by Tycho-Brahe and Kepler; which would become dark nebulæ invisible in a short time, but when produced by enormous suns, would continue visible for very long periods; and this is the commencement of aggregation round a central sun. Each piece of debris would move in its own orbit like the very elongated orbit of comets; in fact each piece would be a comet. Thus; Nebulæ, at the first commencement, really consists of millions of comets, moving in orbits interlacing and intersecting each other. There are comparatively few now left in our solar system. Professor Stephen Alexander suggested the idea that the comets and the asteroids had a common origin. This hypothesis was renounced in consequence of the difference of the orbits. (Cosmos, Vol. IV., page 183.) A comet and an asteroid are different in their orbital motions; but when an ascending comet meets a descending one a collision takes place. They meet at a considerable angle, and by the resolution of forces move in a new orbit compounded of the united orbits of the now united body; the new orbit is less elongated and much more circular than either of the former ones; the broken debris becomes the aerolites which abound in our system. After a few more collisions ascending and descending, the united comets become asteroids, each conjunction making the orbits more circular, and developing great heat. This is the first phase or comet period of aggregation from comets to asteroids. The second phase is from comets and asteroids into planets, the movements being caused primarily by the power of the central body. But the aggregation is owing to the interlacing orbits bringing the bodies in such near proximity that their mutual attractions becomes superior to the restraining power of the central body; and they unite, developing heat at each conjunction. Beila's comet intersects the orbit of the earth; it also intersects the orbit of Encke's comet. On the 29th of October, 1832, Beila's comet passed through the earth's orbit a month before the earth passed the same spot; and Humboldt states (Cosmos, Vol. I., page 108) there is a possibility of the inhabitants of the earth witnessing an encounter between these two comets, and, possibly, of their amalgamation. He also adds, events of this nature must have been of frequent occurrence in the course of millions of years in the regions of space. In another place, (Vol. IV., page 226,) he alludes to the manifold analogies which some meteoric stones present as rocks, with the older so-called trap rocks. Both Beila's and Encke's comets pass round the sun from west to east like the planets. The planets all revolve on their axis from west to east. If a body is revolving, and a portion becomes detached without rotary disturbance, the detached portion will continue to revolve in the same

direction with equal velocity; and if two detached bodies are revolving in the same direction, and become united without rotary disturbance, they will continue to revolve in the same direction.

A given mass falling from a given height is equal to an equal mass raised to the same height, or it is equal to a lesser mass raised to a greater height, or the greater portion of the force may be absorbed in developing heat, and yet raise a lesser weight to an equal height; and this is precisely what takes place at the conjunction of two suns which have approached on curved lines—collision, heat, rotary motion; enormous quantities of debris thrown into space, nearly in the plane of rotation of the central body, each portion of debris revolving in the same direction as the central body; intersection of orbits; conjunction of masses; the rotary motion continued in the same direction after conjunction, sometimes with rotary disturbance, but the mean velocity not greatly varying, the larger planets maintaining their velocities better than the smaller ones. The position of the planets so nearly in one plane; the coincidence of their motions in one direction; the motions of the few comets yet left; the meteoric stones and their identity with the older trap-rocks, and the materials composing the crust of the earth, all give their testimony in the strongest and clearest manner as to the action of rotary motion and centrifugal force, and as to the effect of rotary motion being caused by the conjunction of two spheres being made on curved lines; the fact that the binary stars are so numerous must be considered sufficient proof, for by what other known mode of action can such motions be produced?

VIII. The peculiar arrangement of the planets of our system, in respect to distance from the central body, commonly known as the Bode Law, or the law of distances, has caused much discussion among astronomers. It has even been denied that it is a law at all. Sir John Herschel, in his outlines referring to this doubling of distances, says:

"*No account a priori, or from theory, can be given of this singular progression, which is not like Kepler's laws, strictly exact in its numerical verification;* but he expresses a *strong belief that it is not a mere accidental coincidence, but belongs to the essential structure of the system.*"

Dr. Olbers conjectured that the asteroids were the fragments of an exploded planet, whereas they, with the remaining comets, are all that is left incompleted in our system. Future generations may yet see the asteroids, now numbering 113, aggregate into the smallest planet of our system. During the aggregation of masses round a central power, the masses will naturally range themselves in receding from that centre, each one about double the distance of the one preceding it from the main centre; for as the central power diminishes as the squares of the distances, while the attractive force of the planetary masses for each other remains the same, with equal masses at

equal distances, therefore every time the distance from the central body is doubled, the mutual attraction of the masses for each other becomes relatively superior to the restraining power of the central body, and when the former are moving in eccentric orbits and brought into near proximity, not being sufficiently restrained, they will continue to aggregate until the distance of the masses being also about double the restraining superiority of the central power is restored. The relative positions of the satellites of Jupiter indicate that they were formed by the same process from millions of debris moving in eccentric orbits round the central body. The planets of our system do not follow this law exactly. To be all in perfect equilibrium, they should be exactly double the distance in receding from the sun, and their masses equal. But their masses are not equal, and therefore the distances should not be equal; but the inequalities of mass do not vary with the distances. There are, therefore, great differences in their stability. Mercury, being nearest to the sun, is less deflected from its orbit, with equal power, than any other planet in our system, and Neptune would be most deflected from his orbit. If the planets were all of equal size and density, and situated at exactly double the distance receding from the sun, then Mercury would deflect Venus from its true orbit double the distance, the latter would deflect Mercury; and Venus would deflect the Earth double the distance the Earth would deflect Venus; and the Earth would deflect Mars double the distance the latter would the Earth, and so on all through. But these inequalities, according to Sir John Herschel, are very important as contributing to correct the perturbations, and prevent the effects of accumulation.

All the authorities agree in confirming the fact that the law of distances is not understood. It is, in fact, one of Nature's irregular laws, and can only be explained on the aggregation theory; and this may, therefore, be considered as another proof of the correctness of the latter.

IX. We may now understand how, during the periods of alternate fire and flood, tornado and earthquake, the materials composing the sun and planets were ground and assorted by the elements, compressed by the collisions, and hardened by the fires; how the denser metals and minerals were constantly tending to the interior depths, and as constantly again being brought upon the surface by the action of aggregation, and again subjected to the grinding detrision of the elements. We may also obtain clearer ideas as to the interior construction of our planet. It will account for the great variation in the composition of the earth's crust, and many other phenomena otherwise difficult to explain. Humboldt remarks respecting the phenomena of the earth's crust, ("Cosmos," Vol. I., page 73:) "*It remains to be considered whether by the operation of thought we may hope to reduce the immense diversity of phenomena comprised by the Cosmos to the unity of a principle and the evidence*

afforded by rational truths. In the present state of empirical knowledge, we can scarcely flatter ourselves with such a hope." The author of the Cosmos also observes, in another place, when speaking of rocks, (Vol. I., page 254:) "*A plutonic action seems, to a certain extent, to have taken place in the sedimentary strata.*" There is great diversity of rocks in the earth, and the metals and minerals are very unequally distributed.

In immense districts of the Andes there are no signs of granite; in some countries no iron; in the volcano Mauna Loa, in the Sandwich Islands, scarcely any pumice; and New Caledonia, though surrounded by basaltic and other volcanic islands, has nothing but plutonic rock. In another place Humboldt, in allusion to the volcanoes of Mexico, remarks as follows, (Cosmos, Vol. I., page 377:) "*From this brief sketch it will be seen, and it is well deserving of notice, that in the long range of volcanoes which extend from ocean to ocean, there are not two immediately succeeding each other which are of similar mineralogical composition.*" Thus it appears the interior of the earth is by no means uniform or homogeneous; but, like the crust, is made up of every variety of materials. I would suggest that the earth cannot ever have been in a perfect molten condition, and it by no means follows that it has a molten core. I submit that the aggregation theory alone affords a rational solution of these discrepancies in geological science. It is also probable that many of the more ancient rocks were not formed on the earth, but at a much earlier period, as demonstrated by their similarity to meteoric masses.

A paper by Mr. Atkinson, in the Memoirs of the Astronomical Society of London, estimates the mean temperature of the Equator at 86° 55′ Fahrenheit; and M. Arago concluded, from the results of Scoresby, Perry, and Franklin, that the mean temperature at the pole was 13°. We shall not, therefore, greatly err in assuming the mean temperature of the surface of the earth at about 50° Fahrenheit. Dr. Ure, in his Dictionary of Arts, gives the evaporation of surface as follows: One square foot exposed to a fire will evaporate 725 grains of water per minute; the same surface at a temperature of 88° evaporated 31 grains, and in a moist atmosphere only about 21½ grains, varying from 23 to 34 times. During the volcanic disturbances of 1868 and 1869 there were very destructive rain storms and floods in the United States, and in various other parts of the world. Several occurred in the United States with a fall of six inches of rain in a few hours; and one which occurred within the observation of the author, in August, 1868, lasted about four hours, and during the last two hours it was estimated, by actual measurement, that 7½ inches of rain fell, and the first two hours were considered equally violent; and it was this unusual protracted severity which induced the author to take measures for estimating its quantity. The mean annual rain-fall on the globe has been estimated at 36 inches. It may, therefore, be assumed that when our earth, during the aggregation

of millions of comets and asteriods, (by calculation it would require 73,049 asteroids, each containing 6,816,262 spherical miles, to form our earth,) was at a very elevated temperature—on its surface even as low as 250° Fahrenheit—the water would be in the condition of steam, and during the ages it was cooling the radiation of heat from the upper surface of the atmosphere would precipitate the most tremendous storms of rain—as high, probably, as 100 inches in one hour—frequently accompanied by cyclones and violent earthquakes. During this period the earth would be enveloped in gloom and darkness, and the light of day would be almost excluded by the deep, dense, cloudy atmosphere, and the lurid glare of the numerous volcanic eruptions would impart to the night an aspect of terrific grandeur. As the ages rolled on the surface of the earth and the waters became cooler by the slow action of radiation. The fitting temperature stimulated into existence the first living organisms, and vegetation also commenced; but the cooler crust of the earth is yet of inconsiderable thickness, and the connection of heat from the interior almost equal the radiation through a long period of time, thus preserving a heated temperature in the waters and the atmosphere, and the continuance of great evaporation and frequent violent storms, while occasional large masses of debris fall upon the earth, contributing to the materials for the numerous strata, and marking variations in their character and constitution. Immense quantities of minute marine shell fish also contribute to make up the strata, the ever-restless waters and other elements ceaselessly grinding the materials therefor. The frequent and sudden changes of character in the strata indicate the action sometimes of volcanic upheavals and submergings, and sometimes of additions of matter from ultra-mundane sources. In the course of many ages a rank vegetation, stimulated by the yet warm and moist atmosphere, covered the swamps and marshes, and gradually extended over all favorable locations. These again became submerged, and covered by deposits forming other strata, the vegetation being converted into coal. According to Humboldt, the dense vegetation of the period consisted of a great variety of ferns, coniferæ, palms, and other species, about 400 in all, and he further remarks as follows, (Cosmos, Vol. I., page 280·) "*In order to give some idea of the luxuriance of the vegetation of the primitive world, and of the immense masses of vegetable matter which was doubtless accumulated in currents, and converted in a moist condition into coal. I would instance the Sarbrucker coal measures, where* 120 *beds are superposed* on *one another, exclusive of a great many which are less than a foot in thickness.*" Aerolites vary greatly in their composition. According to Humboldt, some contain 96 per cent. of iron, others only two per cent. of iron, others no metallic iron, and one earthy ærolite broke up in water. According to Berzelius, the chemical elements of ærolites consist of the same as those distributed throughout the earth's crust, and are 15 in number, viz., iron,

nickel, cobalt, manganese, chromium, copper, arsenic, zinc, potash, soda, sulphur, phosphorus, and carbon constituting nearly one-third of all the known simples. The first commencement of aggregation round a central power would produce them in immense quantities, as the force and velocity of the scattering debris would be far greater than the attractive power of the united pieces could restrain. These fragments would fly in every direction; and large quantities of those which received a retrograde impulse would fall back into the sun. Others would fly round the sun in all directions. The frequency with which they fall upon the earth is an indication that they are yet very numerous

X. The satellite of the earth is unusually large in proportion to its primary. There is reason to suppose that it was aggregated as an independent planet in an orbit of its own. The orbit was probably situated between the Earth and Mars, nearer to the Earth than Mars. A favorable disposition of the exterior planets has deflected and retarded it it in its course, and a favorable disposition of the interior planets has increased the recoil, and it has fallen in front of and crossed the Earth's path, within the Earth's attraction, and being retarded by their mutual attractions, and the Earth accelerated proportionally moved on, and the satellite commenced to accompany the Earth in its course. Its mass, according to Lindeman, is one-eightieth of the Earth; the force of its attraction on its surface 0.164, the Earth being one thousand equals one-sixth the attraction of the Earth; its density 0.619 to Earth's one thousand. The probabilities are that it revolved on its axis from west to east, like the other planets. It is probably composed of the same description of materials as the earth, and has water and an atmosphere; and from its appearance it has had seas. If we take it into consideration its density, and assume it to be composed of the same materials as the earth, and that six terrestrial pounds would only equal one pound upon the moon, it becomes reasonable to suppose it must have immense caverns caused by the expansive gases of the numerous volcanoes.* Indeed, over one-third its volume must consist of empty space, which, from the cooling of the crust, remains in that condition, something like a vast mineral sponge. As the interior fires cooled, the water and the atmosphere would pass into the inside. The porous nature of the crust permits the entrance of some light; the crust is cool and dry; the radiation of heat extremely diminished, the interior may still retain a genial warmth, and its vast caverns abound with animal and vegetable life. It might even be better than our Polar regions for intelligent beings; and if the enclosed waters occupy the central area, which is quite probable, then there would be a tide every revolution passing backwards and forwards past its centre, during rotation; and the continual change of motion of the waters would soon stop the rotation, and make it settle with one side towards

* See Appendix.

the earth, as the power which influenced it most, and the fact that it does hold one side to the earth somewhat confirms this hypothesis. It is too small to ever have been conspicuous for storms, and its centre probably consists of immense masses of rocks partially filled with lava, so there would be no grinding detrision to form strata. Humboldt, in Cosmos, Vol. IV., page 114, gives an account of a singular tradition or historical myth: "*The Pre-Hellenic Pelasgian inhabitants of Arcadia called themselves Proselenes, because they boasted they came into the country before the moon accompanied the earth. Pre-Hellenic and Pre-Lunarian were synonymous.*." In a series of notes he gives a series of passages from the ancients upon the subject, and in another note on page 115 he adds as follows: "*In the New Continent there is, upon the elevated plains of Bogota, the race of Muyscas ar Mozcas, who, in their historical myths, boast of a Proselenic antiquity. The origin of the moon is connected with the tradition of a great flood,*" *etc.* Thus both the Old World and the New World have a similar tradition.

XI. In Van Nostrand's Magazine for October, 1869, I first read of Mayer's great discovery, the mechanical equivalent of heat, and about the same time I saw, in Ennis's Origin of the Stars, that Mayer had the honor of first suggesting the collision of two stars to produce a sun. The rotary motion by collision, and the great generation of heat, had occurred to myself several years before in South America. A Fahrenheit thermometer placed on the sand, under a vertical sun, on a bright, clear day, within the tropics, indicated 125°, with this data—If we assume four radiating lines extending from the centre of the sun to the earth, and intersecting the corners of a square foot upon the sun's surface; at double the distance from the centre these lines will enclose 4 square feet; at three times the distance $3x3 = 9$ square feet. It will be manifest that the temperature will decrease inversely as the squares of the distances, therefore it will then be only one-ninth the temperature of the sun at the distance of 3 times the sun's radius; therefore, the distance of the earth being 214.65 radii, and $214.65^2 = 46{,}074$; therefore, the earth is 46,074 times cooler than the sun; but as the thermometer indicated that the earth is 125°, then $125 \times 46{,}074 = 5{,}759{,}250°$ Fahrenheit as the temperature of the sun's surface. If we now multiply $5{,}759{,}250 \times 85.65$, the number of terrestrial pounds in a cubic foot of the sun, it will stand as follows:

$5{,}759{,}250 \times 85.65 = 493{,}164{,}577$ units of heat in each cubic foot of the sun.

According to Mayer, 772 lbs. falling one foot per minute, or 1 pound falling 772 feet per minute, is equal to one unit of heat developed, and one unit of heat will raise 1 pound of water 1° degree Fahrenheit.

It has been estimated by astronomers that the comet of 1680, in its perehelion passage, approached within one-sixth of the sun's diameter from his surface, or within 128,466 miles. The velocity at that period was estimated

at 344 miles in a second, or 1,816,320 feet; and by calculation, if it had actually gone to the sun's surface, it would have been at least 887,754 feet more, making a total of 2,704,074 feet per second. Then assuming our sun to be formed by the conjunction of two suns, each equal to one-half the mass of the sun, their united velocities at the moment of collision will certainly be equal to the velocity of the comet above mentioned, or 2,704,074 feet per second, as the same mass of matter will produce the same velocity whatever be the proportion of the two parts to each other. If the mass of the comet was one thousandth part of the sun, then the sun would approach toward the comet 1 foot, while the comet approached toward the sun 999 feet; and if the masses were as one to four, then the one would move 200 feet and the other 800 feet, and so on. The density of the sun is to water as 1.37 to 1. Then the case will stand as follows: A cubic foot of the sun is just about one-fourth the density of a cubic foot of our earth, by calculation, 85.63 pounds; but one terrestrial pound when upon the sun is equal to 27.9 pounds; then $\frac{2,704,074 \times 27.9 \times 60 \times 85.63}{772} = 502,091,269$ units of heat in every cubic foot of the sun. The result obtained by the thermometer was 493,164,577 units per cubic foot, and if we allow 2¼ degrees more for loss in the atmosphere, the two results will be equal.

Sir John Herschel, at the Cape of Good Hope, ascertained by experiment that a square foot of dark surface exposed to the sun's rays acquired heat at the average rate of 5 units per minute, and as the proportion is 1 foot of sun to 46,074 feet of earth surface, therefore 46,074 x 5 = 230,370 units of heat per minute radiating from one square foot of the sun. By calculation, this is sufficient to run an engine of 378 horse power. Every square foot of the sun's surface radiates the heat from the mass beneath, extending to the centre of the sun, a mass equal to 781,945,768 cubic feet of molten matter, heated about two thousand times hotter than molten iron, and each cubic foot containing over 500,000,000 of units of heat. By calculation, at 230,370 units radiating per minute from the single foot of surface, it would require 25,440 years to reduce the sun's power upon the earth 1° Fahrenheit, and this assuming no additional supply of heat meanwhile, which is by no means necessarily obliged to be the case, as I will endeavor to demonstrate presently.

XII. Two theories of light have been advanced by eminent mathematicians, viz.: The corpuscular theory, by Sir Isaac Newton, and the undulatory theory, by Huygens, and both have their advocates among eminent men. The first theory, according to Sir John Herschel, defines light to consist of matter in extremely minute particles, possessed of inertia and endowed with attractive and repulsive forces, and projected or emitted from all luminous bodies with nearly the same velocity, about 192,500 statute miles per second (according to the latest authorities). This theory is elaborate, and the greater part of it very clear and intelligible, while other parts are more obscure.

The second or undulatory theory is as follows: That an excessive rare, subtle, and elastic medium or ether fills all space, and pervades all material bodies, occuping the intervals between their molecules, and either by passing freely among them, or by extreme rarity, offering no resistance to the motion of the earth, the planets, or comets in their orbits, appreciable by the most delicate astronomical observations; and having inertia, but not gravity, that the molecules of the ether are susceptible of being set in vibratory motion like waves, by the agitation of the particles of ponderable matter, which waves, are remarkable for the extreme rapidity of their motions. Each of these theories have their dilemmas, and it is at present impossible to say which is the true one. The undulatory theory has been compared to the propagation of sound. But sound cannot be propagated without a medium, as air, gases, fluids, and solids, and it is propagated through solid metallic substances, as iron, far more rapidly than through the air. Air, unless compressed more or less, as in our atmosphere, will not transmit sound; and it would appear, therefore, on dynamic considerations, that the ether must also be under considerable compression, or it could not make 500,000,000,000,000 of vibrations in one second. I have seen the argument advanced, in favor of the undulatory theory, that the enormous waste resulting from the corpuscular theory, viz.: The superficies of a sphere, the diameter of the earth's orbit, is to the area of a disc the diameter of the earth as 145,261,309 to 1, and the light which the other planets receive scarcely affects the result; hence the enormous apparent waste of light and heat is urged as inconsistent with the economy of Nature. It has been claimed that the undulatory theory avoids this waste; but it is evident that light, heat and power are synonymous, being respectively converted any one into the others. In either theory the heat reaches the earth, and as nothing can originate from nothing the effect must have a cause, and the effect is, therefore, as much lost by one theory as the other. We know almost to a certainty that the sun must be receiving constant additions, according to Olbers and Quetelet (Cosmos, Vol. IV). A single observer can, on ordinary nights, see from six to eight meteors or shooting stars per hour, and assuming each person capable of watching one hundred square miles, or an area ten miles square, it would require nearly 400,000 men on the dark side only to watch, and if we allow only five seen by each, it will make 2,000,000; but the superficies of the earth's orbit, as before stated, is 145,261,309 to 1, or over 145,000,000 to 1, which, being multiplied by 2,000,000, gives the enormous quantity of 290,522,618,000,000. A very large proportion of these must reach the sun, and striking with the velocity due to that all-absorbing power, would certainly appear to be sufficient to continue the light of the sun indefinitely. When shooting stars strike the upper regions of our atmosphere they burst into a small but brilliant light, but when striking the dense, heated atmosphere of the sun with the immense velocity of

the comet before mentioned, the effect would be brilliant in the extreme, just indeed as we see it. Mayer has the honor of first advancing this doctrine of meteors falling into the sun as fuel. His ideas were pronounced extravagant but they are better appreciated now. Of course rocks and stones would make poor fuel, in the usual acceptation of the term, and indeed no description of fuel could be so concentrated as to produce, as mere fuel, the effect we see; but every description of matter, when used in the manner indicated above, would produce the magnificent effect we witness.

According to Roscoe, Dr. Wollaston was the first person to observe the wonderful dark lines in the solar spectrum, which, like a messenger from the regions of space, makes us acquainted with the chemical constitution of the sun and the stars, even to the most minute particulars; but we are indebted to Fraunhofer, a German optician, for the first map of these mystical lines. Fraunhofer mapped 576 of these lines, and concluded, after long consideration, that whatever produced these lines was something beyond and outside our atmosphere, and this conclusion was afterwards borne out.

The same authority further says: "The science of spectrum *analysis rests upon the theory of exchanges. This states that a gas or any other body which, when incandescent, is perfectly transparent to a certain class of rays, cannot emit these rays, but that it must emit any rays to which it is not perfectly transparent. To illustrate which, the sodium spectrum consists of one double bright yellow line, and this bright double yellow sodium line is exactly coincident with Fraunhofer's dark double line D. The spectrum of a Drummond light is continuous; it contains no dark lines or spaces. We here learn the important fact that if between the prism and the Drummond light a soda flame be placed, a dark double line identical with Fraunhofer's double line D, is produced; if instead of using Drummond's light we use sunlight through the sodium flame, we see that the line D becomes much more distinct than when sunlight alone is employed. The sodium flame has therefore the power of absorbing the same kind of rays as it emits*; hence the light from sodium COMBINES WITH and ABSORBS the light produced by sodium, and the light from iron or any other metal COMBINES WITH and ABSORBS the light from iron, &c., and so on with other metals and all the primitive elements." I will now quote another paragraph from Roscoe (page 288). It is respecting the spectrum of a nebulous spot, as follows: "*If we had evidence that the other lines which presents themselves in the spectra of nitrogen and hydrogen were quenched on their way to us, we should have to consider their disappearance as an indication of a power of extinction residing in cosmical space, similar to that which was suggested from theoretical considerations by Cheseaux, and was afterwards supported on other grounds by Olbers and the elder Struve. Further, as the lines which we see in the nebulæ are precisely those which experiment shows would longest resist extinction—at least, so far as respects their power of producing an impression on our visual organs—we might conclude that this absorptive*

property of space is not elective in its action on light, but is of the character of a general absorption, acting equally, or nearly so, on light of every degree of refrangibility." Here we have a distinct admission, supported by the opinions of three eminent men, that possibly *space possesses* the quality of *absorbing light of every degree;* a most important admission in its consequences, as I will demonstrate presently.

I again quote from Roscoe, where he alludes to some experiments on colored flames by Sir John Herschel (page 118), as follows: "It is also remarkable that alcohol burnt in an open vessel, or in a lamp with a metallic wick, gives but little of the yellow light; while, if the wick be of cotton, it gives a considerable quantity, and that for an unlimited time." (I have found other instances of a change of color in flames, owing to *the mere presence* of the substance, which *suffers no diminution in consequence.* Thus, a particle of muriate of lime on the wick of a spirit-lamp will produce a quantity of red and green rays for a whole evening, without being itself sensibly diminished.) Again (page 119), he refers to the statement of Talbot, that a piece of chloride of calcium, by its mere presence in the wick of a flame, and without suffering any diminution, causes a red and green line to appear in the spectrum. And on the same page he remarks, "Wheatstone has already noticed that when the poles of an electric battery consist of two different metals, the spectrum contains the lines of both metals. Hence it became of interest to see whether a compound of these metals, especially a chemical compound, also gives the lines of both metals, or whether the compound is distinguished by the occurrence of new lines. Experiment shows that the first supposition is correct. Swan showed how extremely minute was the quantity of sodium required to produce the yellow line." At page 135 we learn that it was Faraday who first declared that the electric spark consists solely of the material particles of the poles and the medium through which it passes. This may be explained to mean that the particles from the poles and in the medium through which it passes give the electric current the materials for the light which renders it visible, not the materials for the electricity; therefore light is material, and it can be produced from every description of material, but it is matter so extremely attenuated that it is extremely difficult to measure the quantity. On page 63 Roscoe gives, as illustrations of the extremely minute quantities of different kinds of matter which can be easily detected, as follows: sodium, one one-hundred-and-eighty-millionth part of a grain; lithium, one six-millionth part of a grain; stronium, one-millionth part of a grain; calcium, one-millionth part of a grain. It therefore follows that different substances differ in the quantity of light they give. And at page 67, in illustrating an experiment, he (Roscoe) remarks: "Now the sodium is very nearly burnt out, and the lithium will soon disappear, whereas the green bands, produced by the less volatile barium compounds will remain for a greater

length of time. Here we have direct evidence again that there is consumption of matter in the production of light, and that consequently light is matter. Indeed, it appears contrary to all scientific evidence to assume that actinic or chemical power can exist in mere undulations without the presence of actual matter. Chemical affinity is a property of matter, not of motion.

XIII. Cosmos, Vol I., page 106, we learn that "*Encke's comet has a period of revolution of about three and one-third years, but from a careful comparison of the epoch of its return to its perihelion, the remarkable fact has been discovered that these periods have diminished in the most regular manner between the years* 1786 *and* 1838, *the diminution amounting in the course of* 52 *years to about one and eight-tenth days. The attempt to bring into unison the results of observation and calculation in the investigation of all the planetary disturbances, with the view of explaining this phenomenon, has led to the adoption of a very probable hypothesis that there exists, dispersed in space, a vaporous substance capable of acting as a resisting medium. This matter diminishes the tangential force, and with it the major axis of the comet's orbit;*" and he adds the following significant remark: "The value of the constant of the resistance appears to be somewhat *different before* and *after* the perihelion; and this may perhaps be ascribed to the altered form of the small nebulous star in the vicinity of the sun, and to the action of the unequal density of the strata or cosmical ether." We will presently endeavor to give another reason for this resistance. It is well known that the tail of a comet always points directly from the sun, both in approaching and in receding from that body. The celebrated Kepler attributes this to the action of the stream of light flowing from the sun upon the extremely attenuated matter of the comet's tail. Sir John Herschel describes the tails of comets as often curved, bending in the direction towards the region which the comet has left, as if moving more slowly, or as if resisted in their course. Sir John Herschel further on adds: "Sometimes they make their appearance as faint and slow-moving objects, with little or no tail; but by degrees accelerate, enlarge, and throw out from the head this appendage, which increases in length and brightness till they approach the sun and are lost in his beams. After a time they again emerge on the other side, receding from the sun with a velocity at first rapid, but gradually decaying. It is after thus passing the sun, and not till then, that they shine forth in all their splendor, and that their tails acquire their greatest length and development; thus indicating plainly the action of the sun's rays as the exciting cause of that extraordinary emanation."

The tail of the comet of 1680, immediately after its perihelion passage, was found by Newton to have been no less than 20,000,000 of leagues in length, and to have occupied only two days in its emission from the comet's body, a decisive proof this (in Herschel's opinion) of its being darted forth

by some active force, the origin of which, to judge from the direction of the tail, must be sought in the sun itself.

It will be observed this is precisely the effect which a stream of light, flowing in all directions from the sun, would produce, as also observed by the clear intellect of Kepler. The advocates of the undulatory theory of light regard the fact of Encke's comet being retarded as proof of the universal existence of the ether-filling space.

It will be observed that Humboldt makes the significant remark that the value of the constant of the resistance is somewhat different before and after the perehelion. Now every schoolboy knows that a streamer attached to a flagstaff, if advancing against the wind, will point backwards, but if going with the wind the streamer will go first, pointing in the direction of the wind, provided the motion of the wind exceeds the motion of the flagstaff. Upon this principle, the comet's tail indicates as plainly as anything can do the direction of resistance. It indicates that a constant stream of light is flowing from the sun in all directions, which resists the comet when approaching, and propels it when receding. Thus; when approaching, the resistance is as the square of the velocity—the velocity of light plus the velocity of the comet; receding, it will restore some of the lost velocity by propulsion, on account of the greatly superior velocity of light, but not all, as the propelling power will then be as the square of the velocity, minus the velocity of the comet, and the difference will be permanently lost to the comet, and manifestly this resistance will diminish as the squares of the distances from the sun.

Fracastoro and Appianus say a line produced in the head of a comet, in the direction of the axis of the tail, meets the sun. Seneca observes: "The tails of comets fly from the sun's rays." The tails of comets are first formed on the side nearest the sun, being produced, as generally supposed, by the intense heat; they apparently, in some instances, are blown like a jet of steam a short distance toward the sun, and then driven back as by the action of a strong wind, and this action of a comet's tail does not appear to admit of rational explanation on any other hypothesis than to consider light as matter extremely attenuated, flowing in a constant stream from the sun. Therefore, it follows that during ordinary combustion there are two processes involved; one process converts the greater parts of the material into its original elements of gases, fluids, minerals, and earths, while an exceedingly minute portion is converted into the ultimate attenuation of all matter, as light, heat, electricity, magnetism, or power.

XIV. According to Struve, light travels 166,196 geographical miles per second; this, multiplied by 6,086, or number of feet in a mile, and this by 60, to bring it into minutes, and then divide by 772, the mechanical equivalent in pounds, it would stand as follows:

$$00000001272 \times 700 = 78{,}611{,}554, \text{ or } \tfrac{1}{78{,}611{,}554} \text{ part of a pound,}$$

which converted into decimal fractions, 00000001272 parts of a pound, and this multiplied by 60,688,131,360 feet per minute velocity, gives 771.95 pounds, or 772 foot-pounds; therefore a ray of light, if it develops one unit of heat per minute, with a velocity of 166,196 miles per second = $\frac{1}{78,611,654}$ part of a pound, or $\frac{00000001272}{7000}$ = 000089 = $\frac{89}{1,000,000}$ of a grain.

According to the same authority, light requires 8¼ minutes to pass from the sun to the earth, a distance of 82,342,600 geographical miles, and a ray of light one foot square at the sun, enclosed in four lines radiating from the sun's centre to the earth, will be 214.65 feet square at the earth = 46,074 square feet, and the sun beam enclosed will weigh 169 grains terrestrial, emanating every 8¼ minutes, or 20.51 grains per minute from each square foot of the sun's surface. I find in Van Nostrand's Magazine for January, 1870, an article taken from the "Engineer," (English magazine), which gives the duty of one grain of coal equal 143 foot-pounds. By calculation, one grain of solid matter falling into the sun from space, with the velocity of the comet of 1680, as calculated before, would give 4,522 times the heat produced by one grain of coal used in the ordinary manner as fuel, or one pound would be equal to over two tons of coal used in the most efficient manner; hence the wonderful energy of solar heat and light. It must be remembered that the solar fire can have no ashes and debris; everything is converted into light and heat by the most perfect of combustion, as in that condition only can anything become dissipated into space, where in the silent regions of cold and darkness atom attracts atom by absorption, and the apparent waste of light and heat becomes again formed into light flakes of solid matter, such as constitute the so-called shooting stars, and commence again their journey towards one of the numerous suns which gem the heavens, and thus we have good reason to believe each sun is maintained in its glory and splendor waste, no loss of power or material; and, like all the mechanism of the Great Engineer of the Universe, wonderfully perfect in its operation, stupendous, and sublime.

XV. We will now make some explanations relative to the sun's rotative velocity. It will be manifest that the velocity of rotation resulting from the collision and conjunction of two bodies which, when united, form a mass equal to the sun, and which approached each other with a united velocity of 444 miles per second, on lines tangential to each other or ultra tangential, would have a rotative velocity at least equal to one revolution in one-and-a-half hours; and as the effect should be equal to the cause, it should, therefore, throw off an immense quantity of debris to the remote boundaries of our system. But the sun now only makes one revolution in twenty-five and-a-half days; there must, therefore, have been some cause for this great loss of velocity. The quantity of matter thrown off per minute from each foot of the sun's surface as light will be equal to 20.51 grains; now the total quantity

of matter under each foot of the sun's surface is 781,945,768 cubic feet. It will be evident if we remove one-half this quantity, and replace it with an equal quantity having no rotative velocity, it would reduce the rotative motion one-half, even though this exchange was made grain by grain; and I find by calculation this would require at the rate of 20.51 grains per minute 21,711,765 years; and to reduce the velocity from one revolution in one and a half hours to one revolution in twenty-five and a half days would require this process to be continued 260,531,180 years. Now an action somewhat similar would take place to retard the velocity of the planets. In this case the original matter always remains, and the retardation is produced by throwing upon the surface a given quantity of matter as light having no rotative rotation, which again radiates into space. By calculation, I find this quantity upon the earth cannot exceed $\frac{1}{63}$ part of the earth's volume, or $\frac{1}{272}$ of the earth's mass, during the 260,000,000 of years. Therefore, the inference is, that the material forming the earth and planets was thrown from the sun before it had time to attain the suddenly increased rotary velocity of the sun. There would also be a certain amount of loss at the conjunctions during aggregation. The retarding effect of light upon the planets would be greatest upon the nearest, and least upon the most distant.

Respecting the sun-spots there is a cause which I have nowhere seen mentioned, viz.: The atmosphere of the sun is very deep—estimated at probably several thousand miles—during the vast cyclones which occur, according to the authorities, upon the sun's surface; may not an immense volume suddenly rise from below into the upper regions of the sun's atmosphere? By the sudden relief from pressure it would expand quite a number of times, and become comparatively cool. It seems probable the effect would last as long as the spots do.

XVI. In conclusion, we behold a mighty universe in flames. Not more than $\frac{1}{360,000}$ part of our own system is known to be capable of sustaining man, and of this part at least two-thirds is water. Of the whole system 738 parts is the most intense fire, one part only forming the planetary bodies; man is an extremely minute insect upon one of the smallest of these; our world is a mere spark thrown from the sun, as a small ball one inch diameter to a globe nine feet four inches diameter; and here we are circling round this immense globe of fire for almost countless ages—over 360,000,000 of years; restrained by the centrifugal force from falling into the sun, and prevented from flying off into the cold, dark regions of space by an unknown power which we recognise by its effects only; that mysterious power by which the supreme intellect fashions and molds the stars. Our sun and planets have been formed by aggregation. There is great probability that the same materials have formed anterior systems, which by aggregation were destroyed; and there is every reason to suppose the same fate is in store for ou

system in the remote future. Our sun and planets are being translated through space, in the direction of a point in the constellation Hercules, with an estimated velocity (according to Bessel) of about four millions of miles daily. According to Arago, our sun is a rapidly-moving fixed star—a fact of portentous significance. The universe of matter is ever seeking repose, and never finding it; everything is constantly undergoing changes in longer or shorter periods of time. Our beautiful world must, in obedience to the eternal laws of creation, again pass through the fiery ordeal of destruction and reorganization; and the future geologist of a future world may discover some slight remains burnt into and forming part of the rocks of an anterior period, which he will probably not suspect once formed a part of a living organism, whose history will then belong to the dim, shadowy records of the past Eternity.

All things breathe some language, though we may not understand
The endless combinations seen in Nature wild and grand;
The records of Eternity, the mysteries of Time,
Upon all things are impress'd deep in characters sublime.
From the vaulted dome of Heaven each sparkling ray of light
Flashes its thousand wonders forth, in mystic language bright;
They tell of countless worlds that were, and mighty suns that shone,
'Ere man commenced his history, far back in the ages gone.

All things bear the impress of pre-eminent design,
Of their wondrous adaptation to the lot they are assigned.
Each animal upon the earth, each creature in the air,
Each living thing in ocean's depths its evidence doth bear;
Each tree and plant, each shrub and flower, that blooms upon the plain,
Or clings upon the mountain's side, the sport of wind and rain,
Bears witness to the intellect and wisdom that abound
Through Nature's vast immensity, the infinite profound.

To Thee, O Deity, belongs the intellect sublime
To trace each atom in its course, throughout the endless time.
Thine is the power alone to frame the laws which shape each form,
The wisdom to design, to build, to mold, and to adorn.
The mighty spheres obey Thee, and go their destined race;
Subject to Thy benign rule, each creature finds its place;
And through the endless ages, every moment of each hour,
Each atom of Thy Universe proclaims Thy wondrous power.

APPENDIX.

A few days after placing my manuscript in the hands of the printer, I saw, at a friend's house, Procter's work, entitled, "More Worlds Than One," and finding his views on the moon very similar to my own, in order to keep myself clear of the imputation of plagiarism I wrote to a friend, to whom I had years before communicated my ideas on the present condition of the moon, and received the following reply, which explains itself.

WM. S. HENSON.

ROSEVILLE, NEWARK, N. J., May 24, 1871.

DEAR SIR:

It must be at least three years since you imparted to me your views that the moon, by reason of its different gravity, was inhabited inside, where you had very little doubt but that circumstances were as easily arranged for human life as we find them on our earth. Much more to the same purpose I well remember, which I can vouch for, if necessary.

Yours truly, HORATIO T. HEWITT.

To WM. S. HENSON,
Roseville, N. J.

*** The Author will hereafter publish a supplement, with explanatory illustrations and diagrams, tables, &c., &c.

Printed and published for the author and proprietor, Wm. S. Henson, 566 Orange street, Newark, New Jersey, to whom all orders must be sent.

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